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(71) Applicant : **ACOUSTIC IMAGING TECHNOLOGIES CORPORATION**
**10027 South 51st Street**
**Phoenix, Arizona 85044 (US)**

(72) Inventor : **Garza, Jose Angel Q.**
**1413 E. Hall Street**
**Tempe, Arizona 85281 (US)**
Inventor : **Thomas, David Jay**
**1620 N. Barkley**
**Mesa, Arizona 85203 (US)**
Inventor : **Gilman, George W.**
**900 W. Grove Parkway**
**1133 Tempe Arizona 8583 (US)**

(74) Representative : **Kasseckert, Rainer**
**DORNIER GMBH Kleeweg 3**
**W-7990 Friedrichshafen 1 (DE)**

(54) **Multiple transducer selector.**

(57) An ultrasound imager supports several ultrasonic transducers (18) simultaneously. The imager polls the transducer connection ports (26-1 to 26-4) to determine which transducers are connected to which ports and displays attributes of each transducer in conjunction with a port identification on the screen (14). The user selects which transducer is to be driven using a trackball (40) or cursor arrow which directs an indicator to point to the selected transducer.

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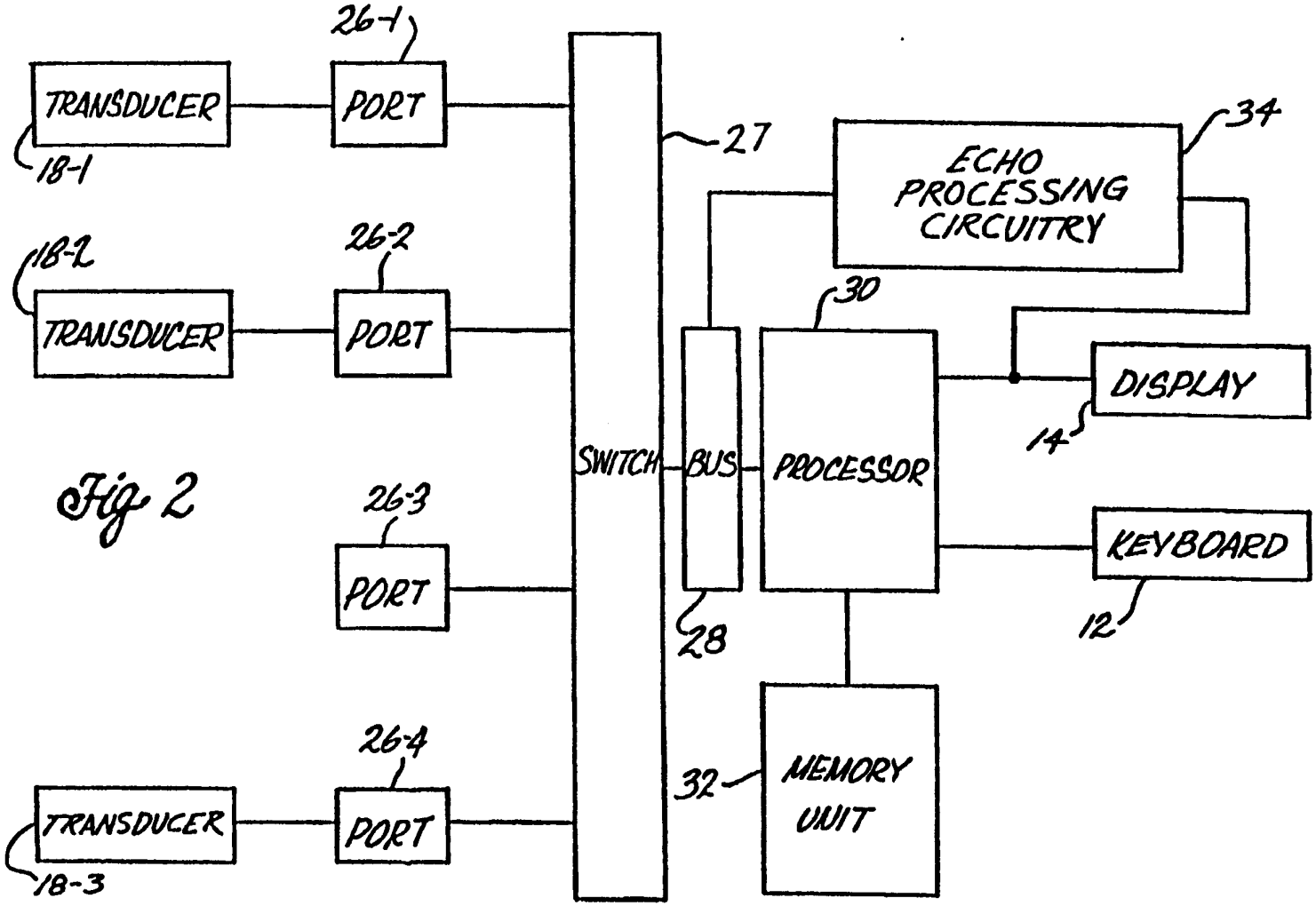

26-1
TRANSDUCER
PORT
18-1
18-2
26-2
TRANSDUCER
PORT
26-3
PORT
26-4
TRANSDUCER
PORT
18-3
SWITCH
27
BUS
28
ECHO PROCESSING CIRCUITRY
34
30
PROCESSOR
DISPLAY
14
KEYBOARD
12
32
MEMORY UNIT

Fig 2

# MULTIPLE TRANSDUCER SELECTOR

## Field of the Invention

The present invention pertains to the field of ultrasound imaging and in particular to an ultrasonic diagnostic scanner capable of supporting multiple transducers.

## Background of the Invention

A variety of ultrasound imaging systems are well known in the art and are valuable for scanning and examining details below a surface. They are particularly useful in medical diagnosis because they allow real time imaging inside a patient's body without surgery and without penetration.

A modern ultrasound imaging system will usually support a variety of different transducing heads. The transducing heads are responsible for actually transmitting the ultrasound signals and receiving the echoes from within the body being examined. Different heads are better suited to different applications. The depth of penetration, resolution and contrast, for example, can vary greatly from one head type to another.

In a conventional ultrasound imaging system the head type is changed by unplugging one transducer head from a transducer port and then plugging a different head into the same port. In addition to being inconvenient, this arrangement causes interruptions in examinations which require that several different transducing heads be used.

## Summary of the Invention

The present invention avoids this problem by supplying a plurality of ports into which transducing heads may be inserted at the same time. The attributes of each transducer may be displayed simultaneously on a screen and the operator need only manipulate a keyboard to select which transducer is to be used.

In one embodiment, the invention is an ultrasonic imager with a plurality of ports, each capable of being connected to an ultrasonic transducer having a plurality of attributes. A control unit polls each port to determine the attributes of any connected transducers. The transducer attributes obtained from the poll are then shown on a display. The attributes may include the transmitting frequency of the transducer, the configuration array of the transducer head and model numbers. The control unit preferably polls each port to determine whether a transducer is connected to each port and displays this information as well.

The control unit drives the transducers connected to the ports and preferably includes a selector for determining which of the transducers is to be driven. The transducer selector has a trackball coupled to an indicator on the display so that, through rolling the trackball, a transducer is selected by positioning the indicator proximate a displayed set of attributes corresponding to the transducer to be selected. Alternatively, the selector has a keyboard coupled to an indicator on the display so that, through keystrokes, a transducer is selected by positioning the indicator proximate a displayed set of attributes corresponding to the selected transducer. The transducers are replaceable and the display is changeable upon replacing a transducer. In another embodiment, the invention comprises an ultrasonic imager with a plurality of ultrasonic transducers for transmitting and receiving ultrasonic signals and converting the received ultrasonic signals to electrical signals, each transducer being independently operable and having a set of attributes. A control unit coupled with the transducers drives the transducers and receives the electrical signals. The control unit has a display for simultaneously displaying at least some of the attributes of each transducer and a selector for determining which transducers are to be driven. The display also indicates which, if any, of the transducers are being driven.

## Brief Description of the Drawings

FIG. 1 is a perspective view of an ultrasonic imager according to the present invention.

FIG. 2 is a block diagram of some working parts of the present invention.

FIG. 3 is a sample screen display according to the present invention.

## Detailed Description

FIG. 1 shows an acoustic imager 10 according to the present invention. The imager has a keyboard 12 for inputting data and a screen 14 for communicating with the operator and for displaying images received by the imager. On either side of the keyboard is a tray 16 for supporting transducers 18. The transducers have a head 20 connected by a cord 22 to an input block 24. The input block mates with ports 26 on a lower panel of the ultrasonic imager. While it is preferred that the imager can support as many as four different transducers, it is not necessary that four be installed at any one time. In FIG. 1 only three transducers are installed, one in port 1, one in port 2 and one in port 4.

The ultrasound imager is operated by, first, selecting a transducer for use, second, inputting this selection on the keyboard together with the desired performance parameters, for example, persistence,

edge enhancement, compression, power output and image width, and, third, holding the transducer head over the body to be examined. The transducer emits high frequency sound waves which penetrate the surface of the body under examination and are reflected back to the transducer where they are detected. The detected sound waves are then converted into images. It is presently preferred that the apparatus described in application Serial No. 07/415,404 filed September 29, 1989, the disclosure of which is hereby incorporated fully by reference herein, be used to produce and process the images. However, imaging can also be done using well known methods and equipment. Techniques for holding a transducer head to obtain the desired image are also largely well known in the art. The imager 10 can support transducers with a variety of transducer array configurations including linear arrays and curved linear arrays.

FIG. 2 is a block diagram of some of the working parts of the ultrasound imager. As in FIG. 1, there are three transducers 18-1, 18-2 18-4 plugged into three of the four ports 26-1 to 26-4. These ports connect to a shared switching network 27 which connects to a shared bus 28 and then to a processor 30. The processor receives instructions from the keyboard 12 and transmits information to the display 14 where it can be read by the processor. The processor also has access to a memory unit 32. The bus, processor, display, keyboard and memory unit are all part of a control unit, which is responsible for driving the transducers and is housed in the main housing of the imager 10 shown in FIG. 1. The switching network 27 like the memory and display is controlled by the processor 30. The bus carries control signals from the processor to the switch in addition to carrying signals between the processor and the ports. The switch has a set of switches or relays which control which of the ports is coupled to the processor.

Figure 1 of application Serial No. 07/415,404 shows a block diagram of an ultrasound imaging system into which the invention can be incorporated. The disclosure of this application has been incorporated fully herein by reference. With reference to that figure, the processor 30 and memory unit 32 herein are part of the main system processor 35, bus 27 herein is part of bus 14, keyboard 12 herein is part of control panel 39 and display 14 herein corresponds to the scan converter 36 and the video display terminal 38. In operation of the transducer selected in accordance with the invention, the echoes received by the selected transducer are coupled by the corresponding port, switch 27, and bus 28 to echo processing circuitry 34, where signals are formed to operate display 14. Preferably, the circuitry 34 is that disclosed in FIG. 1 of the referenced application. In terms of the invention, the signals generated by the processor 30 and the memory unit 32 to form the image of FIG. 3 herein are fed to the scan converter 36 and displayed on the screen of the video display terminal 38 of the referenced application.

When the operator wishes to begin an examination, he first must select a transducer to use. First, he keys a transducer selection start command into the keyboard. This instructs the processor to poll each of the ports 26-1 to 26-4 to determine if a transducer has been plugged into that port and, if so, what its attributes are. It is presently preferred that each transducer use multiple pin electric connectors to the ports. The polarity of three or four of the pins on each transducer input block 24 is hardwired to form an identification number. To poll each of the ports the processor operates the switch 27 to connect with each port one at a time. At each port it detects the identification number hardwired at the dedicated pins. Each identification number is then compared to a look-up table in the memory unit 32. The look-up table contains the attributes of the transducer as well as adjustable transducer operating parameters and instructions on how the transducer is to be driven. The memory unit 32 is preferably a hard disk drive or other rewriteable medium so that transducer identification numbers and transducer characteristics can be updated. After polling each of the ports and comparing the identification number at each port to values in the look-up table, the processor produces the window of FIG. 3 in the display.

In FIG. 3, the window 36 is preferably presented as an overlay to what is already being shown on the display and shows four separate boxes 38-1, 38-2, 38-3 and 38-4. Each box corresponds to one of the ports within the box. The attributes of the transducer installed into each port is displayed. The first box 38-1 displays three attributes of the transducer installed into port one, first, that it has an operating frequency of 7.5 megahertz (MHz), second, that it is a curved linear array (CLA), and third, that it is particularly suited to examining small parts (SP). The second box 38-2 shows that the transducer at that port has an operating frequency of 3.5 MHz, has an 85 millimeter head and also has a curved linear array (CLA). The third box 38-3 shows that the transducer at that port operates at 5.0 MHz and has a 60 mm CLA head. The fourth box shows "NO XDCR" meaning that no transducer has been installed into the fourth port. Any variety of different attributes can be chosen for display, for example, LF for long focus and PVLA for peripheral vascular linear array. Performance parameters as well as model numbers can be displayed in the box to assist the operator in choosing the appropriate transducer.

After the start command is received and the polling is completed, the processor presents the window shown in FIG. 3. The operator must then choose which transducer he will use. In FIG. 3, the third box is highlighted. This indicates that the third port having a 5.0 MHz, CLA transducer is selected. The indication

associated with the third box can take any form; for example, cursors, underlining, flashing or color signals may be used. The selection of the third transducer can be changed in a variety of ways. The keyboard of FIG. 1 includes a convenient trackball 40. The transducer selection is altered by rolling the trackball. Rolling the trackball to the right moves the highlighter to the right and rolling the trackball to the left moves the highlighter to the left. When the desired transducer is highlighted, a select button on the keyboard is pushed to confirm the selection. For example, starting with the screen in FIG. 3, if the operator wished to use the transducer plugged into the first port 7.5 MHz, he would roll the trackball to the left until the first box was highlighted. He would then push the select key, lift the transducer head out of its tray, and begin the examination.

Alternatively, selection commands can be entered using cursor arrow keys. Beginning with the display shown in FIG. 3, the operator could push a left cursor arrow twice to highlight the first box and then push the select key. Other well known keyboard manipulation techniques may be used. The above two methods are preferred for their speed and simplicity. After a transducer is selected, the imager drives that transducer conventionally or as described in application Serial No. 07/415,484 until a new selection is made. After the transducer has been selected, the operator keys a data acquisition command into the keyboard and the echo processing circuitry 34 becomes operative as described in the referenced application.

The present invention makes it unnecessary to continuously remove and reinstall the desired transducer into a single port as required by most ultrasonic imaging machines. It also makes it unnecessary for the operator to remember the characteristics of two different transducers and which port each transducer has been plugged into as required by most multiple port machines. The key attributes of each transducer are displayed on the screen menu when the transducer selection is made. It is preferred that the present invention be integrated into an ultrasonic imager that allows the operator to select all of the operation parameters, for example depth setting, persistence, edge enhancement, compression, gray scale, power output and image width, using the keyboard based on displayed menus. Preferably the processor consults the memory immediately after a transducer port has been selected to obtain the adjustable operation parameters for the selected transducer. These are then displayed on the screen, and the user can adjust the parameters using the keyboard. The selected adjustments are displayed and, when all the adjustments are completed, the user enters a command causing the imager to start driving the selected transducer according to the selected operation parameter adjustments.

Because the processor itself polls the ports to determine the identity of the transducers installed in each port, it is unnecessary to key in the attributes of the transducers as they are installed or even to know the transducer attributes before they are installed. The user simply installs the transducers, selects the transducer to be used first, based on the attributes shown on the display, sets the parameters of its operation, and begins the examination. The other transducers may be removed and replaced even during an examination because the ports are all polled before each selection to determine which transducers are resident there at the time of selection. Using the hard wired identification pins the imager can also be adapted to poll the port being used periodically to confirm the identity of the transducer while it is being used. This allows the operator to switch transducers by unplugging the one being used and plugging a different transducer into the same port without returning to the keyboard. While only a few embodiments have been discussed, the inventors in no way intend to limit their invention to these specific examples. A great variety of modifications and adaptations are possible within the spirit and scope of the present invention. For example, the screen displays may be significantly changed in appearance without detracting from the utility of the invention.

## Claims

1. An ultrasonic imager comprising:
   a plurality of ports each capable of being connected to an ultrasonic transducer having a plurality of attributes;
   a control unit for polling each port to determine attributes of the transducer connected to each port; and
   a display for displaying the transducer attributes obtained from the poll.

2. The imager of claim 1 wherein the displayed attributes comprise the emitted frequency of the transmitter.

3. The imager of claim 1 wherein the displayed attributes comprise the transducer array configuration.

4. The imager of claim 1 wherein the control unit also polls each port to determine whether a transducer is connected to each port and wherein the display displays whether a transducer is connected at each port.

5. The imager of claim 1 wherein the control unit drives the transducers connected to the ports and wherein the control unit comprises a selector for

determining which transducer is to be driven.

6. The imager of claim 1 wherein the selector comprises a trackball for selecting a transducer, the trackball being in communication with an indicator on the display so that, through rolling the trackball, a transducer is selected by positioning the indicator proximate a displayed set of attributes corresponding to the selected transducer.

7. The imager of claim 5 wherein the selector comprises a keyboard for selecting a transducer, the keyboard being in communication with an indicator on the display so that, through keystrokes, a transducer is selected by positioning the indicator proximate a displayed set of attributes corresponding to the selected transducer.

8. An ultrasonic imager comprising:

a plurality of ultrasonic transducers for transmitting and receiving ultrasonic signals and converting the received ultrasonic signals to electrical signals, each transducer being independently operable and having a set of attributes; and

a control unit coupled to the transducers for driving the transducers and receiving the electrical signals, the control unit comprising:

a display for simultaneously displaying at least some of the attributes of each transducer and

a selector for determining which transducers are to be driven.

9. The imager of claim 8 wherein the displayed attributes comprise the transducer's transmitted frequency.

10. The imager of claim 8 wherein the displayed attributes comprise the transducer's array configuration.

11. The imager of claim 8 wherein the display indicates which, if any, of the transducers are being driven.

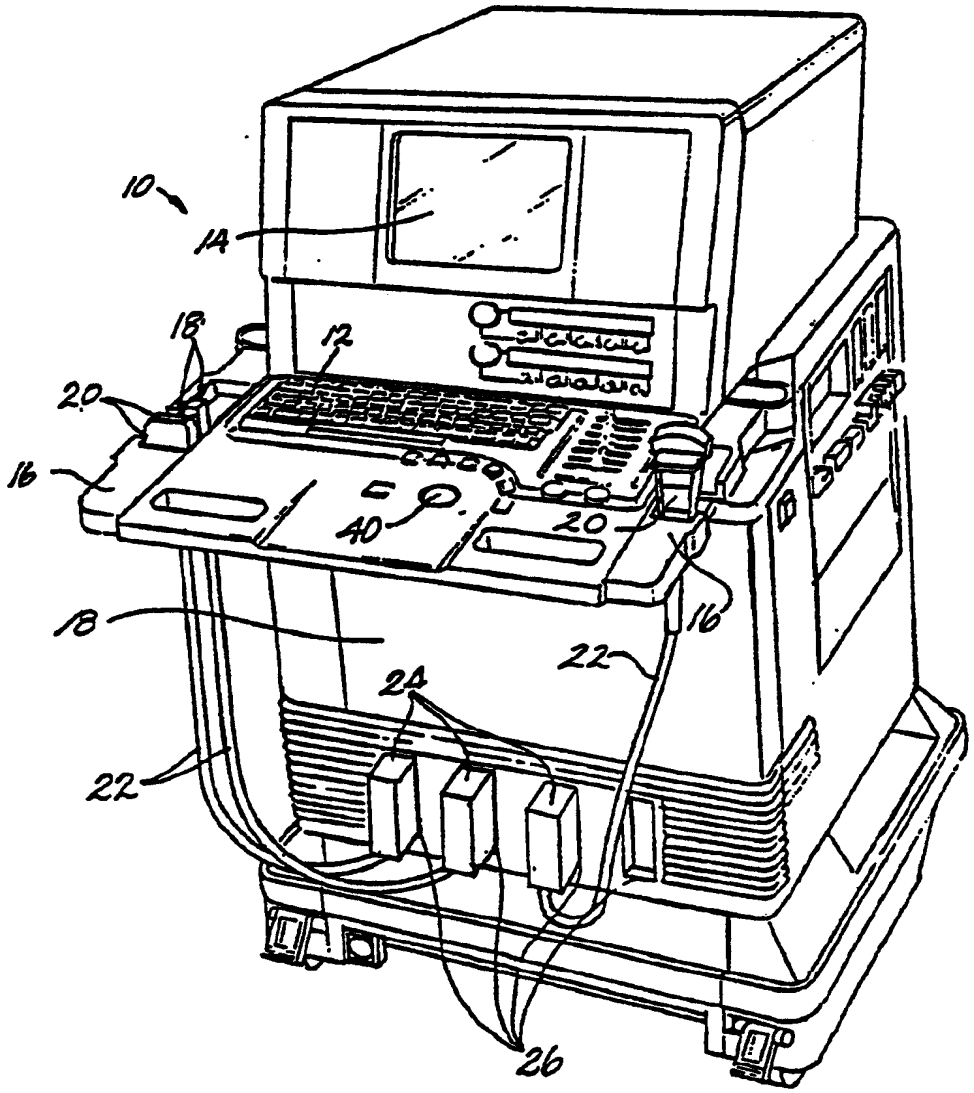
12. The imager of claim 8 wherein the selector comprises a trackball for selecting a transducer, the trackball being coupled to an indicator on the display so that, through rolling the trackball. a transducer is selected by positioning the indicator proximate a displayed set of attributes corresponding to the selected transducer.

13. The imager of claim 8 wherein the selector comprises a keyboard for selecting a transducer, the keyboard being in communication with an indicator on the display so that, through keystrokes, a transducer is selected by positioning the indicator proximate a displayed set of attributes corresponding to the selected transducer.

14. The imager of claim 8 wherein the transducers are replaceable and the display is changeable upon replacing a transducer.

15. The imager of claim 14 wherein the control unit polls the transducers to determine the displayed attributes and the control unit adjusts the display of attributes in response to the poll.

Fig-1



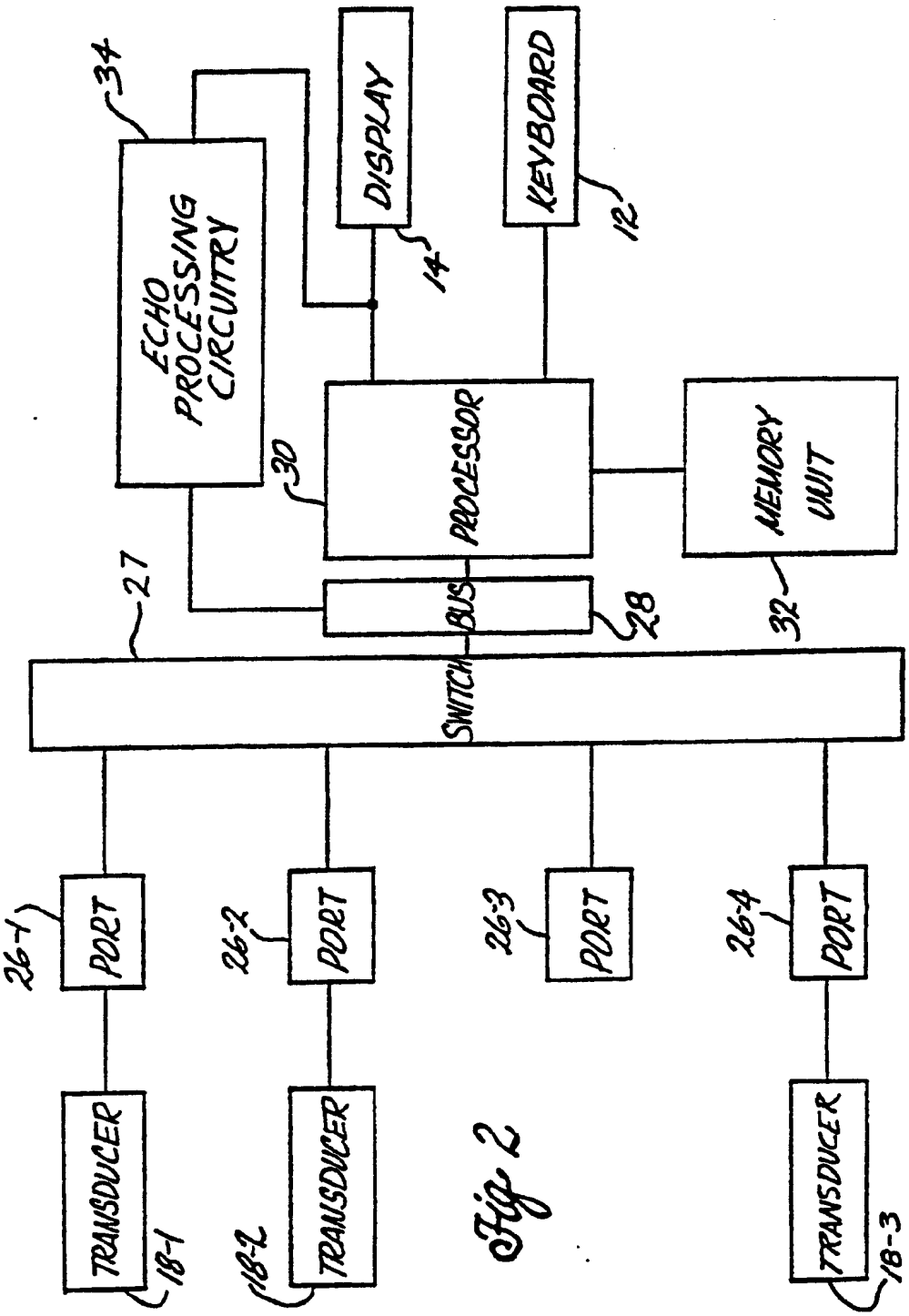



Fig 2

Fig. 3